wearing surface undergoes a resurfacing operation (other than a routine operation), (2) the surface is reconstructed, (3) the road is abandoned, (4) the road is transferred to another public authority for continued maintenance and reconstruction, or (5) the surface reverts to a lower type through lack of adequate maintenance. Approximately 12 per cent of all retirements involved construction on new location.

Estimates of average service lives were obtained from statistical analyses involving the use of survivor curves. Data were available for some types as early as 1903, and a continuous record of the miles remaining in service for each year's construction was available. Each year's construction was analyzed separately when possible. In general it was found that the average service life of the lower types decreased and of the higher types increased during the period of 1910 to 1936. The predominating limits of average service lives were as follows:

Soil surfaced	5 to 14 years
Gravel or stone	6 to 13 years
Bituminous surface-treated	11 to 21 years
Mixed bituminous	14 to 22 years
Bituminous penetration	15 to 17 years
Bituminous concrete	13 to 20 years
Portland-cement concrete	17 to 24 years
Brick or block	18 to 21 years

Additional problems in connection with right-of-way, grading, and structures are being studied in the highway-planning surveys. The road-life studies also include roadway and bridge construction and maintenance cost studies. Eventually, data will be available for many specific analyses of highway costs, economic selection of projects, and other administrative and engineering problems, which in some way depend upon service lives for their solutions. The knowledge will be extended as additional states complete the compilations outlined in the original road-life studies and as they are continued and extended. Further, analyses by individual states will afford results of more specific application to the individual highway systems than can be obtained wholly by this analysis of the combined data from 26 states.

ADVANCING THE INTERESTS OF ENGINEERS

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It may sound like the essence of selfishness to discuss this subject at a time when our nation is at war. But this national emergency is illuminating our past failures and our present needs.

Our engineering educators report a shortage of some fifty thousand engineers properly to man our industrial and military effort on a national scale. To remedy this situation

and to produce these numbers, the educators propose to speed up their production by longer hours and continuous sessions. Certainly they mean to make more than a normal supply of trained engineers available for the nation's needs. Is the conclusion, that this need exists, erroneous; and is the speeded production a proper corrective? Has our profession been consulted or even considered? I don't know. Do you? I do know that I have been reading and hearing about a shortage of doctors for both our civil and military needs, but I haven't read or heard a word from the medical educators about speeding up production.

Anyway, we are about to witness the further crowding of what we have considered a rather crowded field. I trust that our learned friends have reached their conclusions after careful investigation and consideration. To think aloud, otherwise, might brand me as a fifth columnist. But surely there can be no disservice involved if we engineers attempt to analyze this situation—our own problem.

Surely there are some distinguishing earmarks to identify this shortage. Normally, the economics of "Supply and Demand" would hang up a dollar value that would tell the story. Do I need to tell *you* that the dollar demand for the engineer's services is not excessive? This is an Engineering Age. There is a crying need for our services. There is a shortage of engineers. What is wrong with this picture?

For the past fifty years or more, our universities, colleges, technical, and trade schools have been producing quantities of men with various degrees of training. They arm them with some knowledge, a diploma, a degree, and send them into the world to win their way. The school continues to produce, to grow, and to expand. Now, how about their finished product?

The young engineer finds himself in a great democracy pretty thoroughly organized for every purpose except his economic protection. The industries are organized into great trade groups, commercial alliances, and manufacturers' associations. The organized and older professions have legal and other protective barriers for fortification. Even labor, skilled and otherwise, has organization and legislative protection.

Where does the engineer fit into this scene? He has organizations aplenty that are concerned with the advancement of science and the distribution of scientific information; and useful organizations they are for those purposes. But where is his economic protection, his legal status, his professional fortification? A large percentage of his available employment is socialized, to the extent at least that the employer is a unit of government. His conditions of employment are determined by statute or commission; and his voice in his own behalf is seldom heard. His industrial employment is in a well-organized industry that may be most appreciative of the value of his service but seldom willing to compensate proportionately.

This constitutes a rather cruel system that welcomes the beginner and starves the middle-aged and oldster out of his chosen field and into related or different fields of endeavor where the economic battle is not so keen. The result of all this struggle is a much-needed, skilled, and trained group, with a constant supply of replacements and very little incentive for the employer to concern himself with conservation.

Actually, I contend that our profession is so crowded with beginners that the remuneration is established by them. It is only the exceptional individual who can command much more than a well-paid beginner.

A Three-Point Program

Many of us have recognized our problem for some time and have made a start toward its solution. We offer a three-point program for your consideration.

1. Registration is fundamental. It establishes engineering as a profession and creates a legal status for it. It develops a minimum qualification to clarify the variety of training and degrees. Registration also involves a public responsibility and a public service. It protects the qualified against the competition of the unqualified, and is subject to some degree of enforcement.

2. We have developed a professional organization that is dedicated primarily to the welfare of the engineering profession. We are following the pattern of the older and successful professional groups such as the American Medical and Bar Associations, in that we work through local chapters of state and national societies of professional engineers. It is the prime function of these organizations to give the profession representation in matters of legislation, public relations, and enforcement. Attempt is also made to protect the profession against inroads by labor unions and other organizations.

3. We have the all-important task of selling ourselves and our fellow engineers on the need for a united profession to work together for our mutual benefit. Many intelligent individuals still object to registration on the basis that it is undemocratic, in that it interferes with the free exercise of one's talents and rights. Others contend that they were prequalified by their university and that it is undignified for them to submit to a state board for examination. There are objections to the expense involved, and still some inference of a political objection.

There are objectors to our professional societies who say that our profession is over-organized and that we merely compete. Others accuse us of radical tendencies and suspect us of a desire to convert our profession into a labor union.

Despite all this, registration has had a most healthful growth during the past few years, and our professional societies continue to grow in numbers and in strength.

In Indiana we have surely developed a "professional consciousness." We have done quite a bit toward enforcement of the registration act. We have an adopted code of ethics. We now have four local chapters in addition to our state chapter and state society. In the last session of the state legislature, we sponsored three bills. With the able guidance of Engineer Clyde Walb and others, two of them were enacted into law, and the third passed the senate and only failed to get final reading in the house. You city engineers are here today at this Road School because of one of those laws; the other created a merit system for all engineers in state employ.

This represents considerable accomplishment by a militant few and in a comparatively short time. How much more could we do with all of us working together for our common good?

APPLICATION OF GEOLOGY TO HIGHWAY ENGINEERING

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It is common knowledge that many thousands of years ago a series of great glaciers covered most of Indiana as well as many other states during a period of exceptionally cold temperature. The ones most important to Indiana are named the Illinois and the Wisconsin. These glaciers left quantities of stone, gravel, boulders, sand, silt, and clay deposited at great depths over most of the state. These deposits are varied in character, assorted in some places but predominantly a complex mixture, and of considerable importance to highway engineers—from the standpoint both of sources of aggregate and of the performance of highways.

It is likewise well known that the period of glaciers was but yesterday in geological time and that the bed-rocks of the state were deposited millions of years before. A great many of these rocks were of marine origin—the deep massive beds of fossiliferous limestone beneath the soil mantle in various parts of the state constituting but one of many proofs of the fact. These bed-rocks—like the glacial drift—are likewise of importance to highway engineers from the standpoint both of aggregate sources and of highway performance.

However, one might very logically ask how much and how practical is information about glacial drift and bed-rock geology. Do roads perform differently on various types of glacial drift? What relationship is there between bed-rock geology and the design, construction, and maintenance of highways? To answer these questions it will be necessary to analyze the character of the various glacial-drift deposits and to consider some of the important features of bed-rock geology.